Analysis of an Agent-Based Model for Integrated Pest Management with Periodic Control Strategies

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We consider an agent-based model (ABM) for integrated pest management (IPM). The model incorporates stage structure for the pest and predator species. The control strategies of augmentation of the predator species and pesticide application and the pest births occur periodically at possibly different frequencies. Moreover, the amount of augmentation depends on the ratio of the population densities of the pests and predators. We determine conditions under which pest eradication occurs and under which both species persist. We further investigate how varying the frequencies of the control strategies affects the amounts pesticide and augmentation needed to obtain pest eradication or persistence.

To provide further insight to the dynamics of the ABM, we compare the model to analogous impulsive differential equation and difference equation models that exhibit similar behavior, for which we prove conditions for the global asymptotic stability of the pest eradication solution and the permanence of the systems. We also explore the possibility of emergent behavior in the ABM model that does occur in the in two analytic models.